Alberta Geological Survey

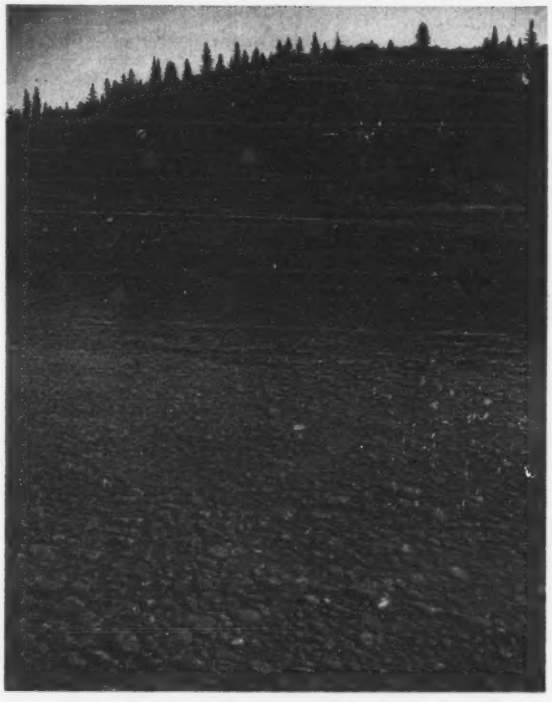
Rock Lines

Summer 2010

Characterization of the Edmonton–Calgary Corridor Waterscape

Alberta Geological Survey (AGS) and Alberta Environment partnered to map the nonsaline groundwater resources of Alberta. We chose the Edmonton–Calgary Corridor (ECC) as the first area to be mapped because of the rapid urban and industrial development, as well as the increased demand for freshwater resources in the region. The ECC study area is bound by surface-water drainage basins and has an area of approximately 50 000 km^2.

We have completed a regional, annual water budget analysis and physical characterization of the hydrogeological framework of the ECC. These results will be compiled in an ECC groundwater atlas. The atlas will be an important resource for water policy decisions, freshwater management strategies and future development in the ECC.



North Saskatchewan River, near Drayton Valley, in an area of groundwater recharge with high-permeability alluvial gravel.

Sustainable freshwater management requires an understanding of the patterns of groundwater-storage potential and yield, as well as the natural exchanges between the groundwater and surface-water systems.

This article outlines the regional hydrological and hydrogeological framework, which will help manage and conserve our groundwater.

Several challenges in completing a water budget for such a large area include

- diverse physiography and climate;
- the presence of four major river basins within the ECC, each with different hydrological response characteristics;
- groundwater well data, which are biased toward shallow installations and vary in age and/or quality;
- hydrological characteristics that change from mountains to plains;
- regional estimation of evapotranspiration that is difficult to evaluate; and
- surface-water control structures and sparse gauging networks that make it difficult to evaluate natural flow regimes.

We designed water budget calculations to illustrate long-term average conditions, since the ECC has high annual variability for all of the water budget

ERCB Energy Resources Conservation Board | AGS Alberta Geological Survey

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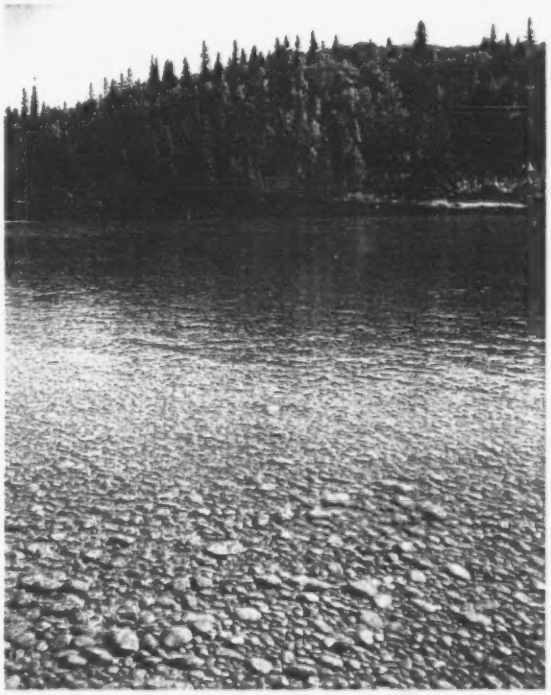

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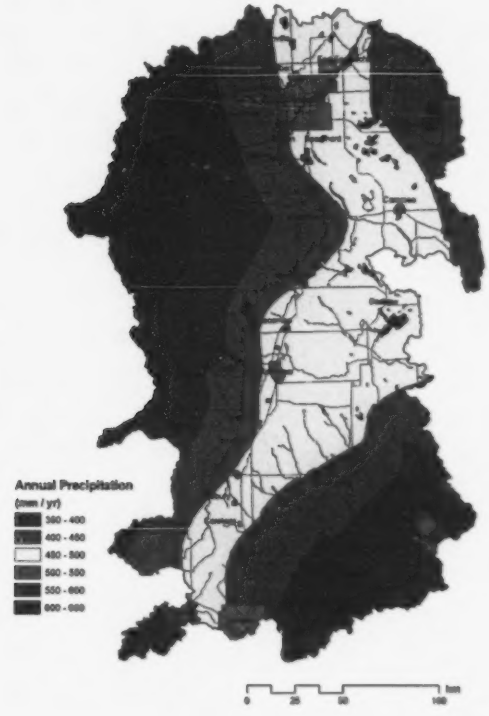

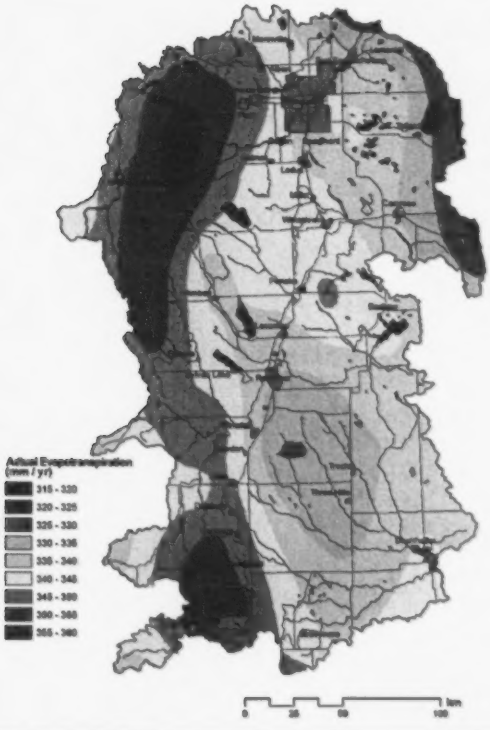

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$$DSs + DSgw = P - ET - Qs - Qgw,$$

where DSs is the change in surface water storage, DSgw is the change in groundwater storage, P is precipitation, ET is evapotranspiration, Qs is the surface water outflow from a drainage basin, and Qgw is the groundwater outflow from the basin (which includes groundwater extracted from pumping wells). All components of the water balance equation are expressed in millimetres per unit area.

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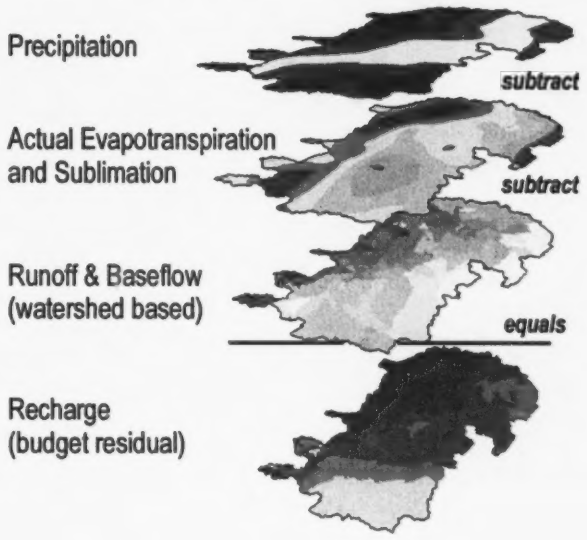
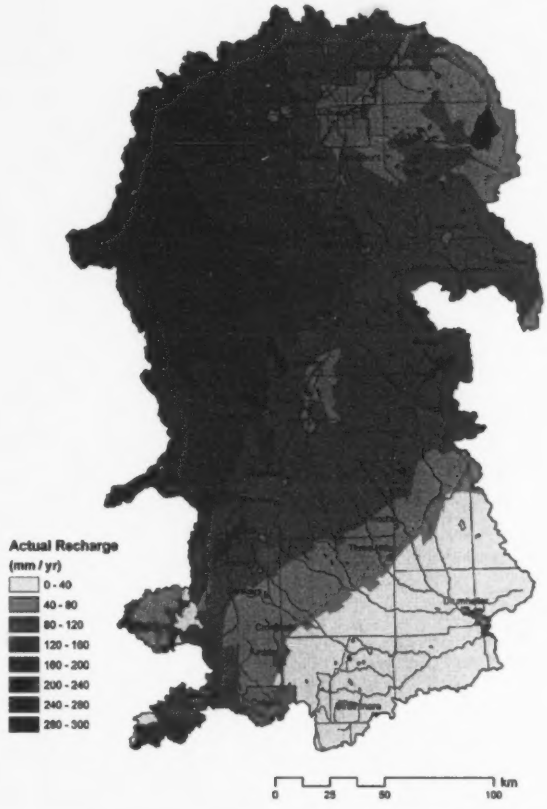
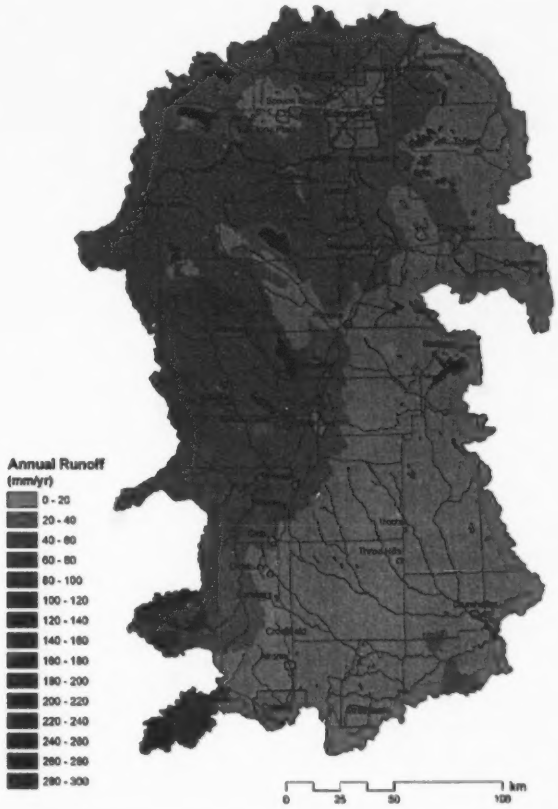
Recharge Calculation







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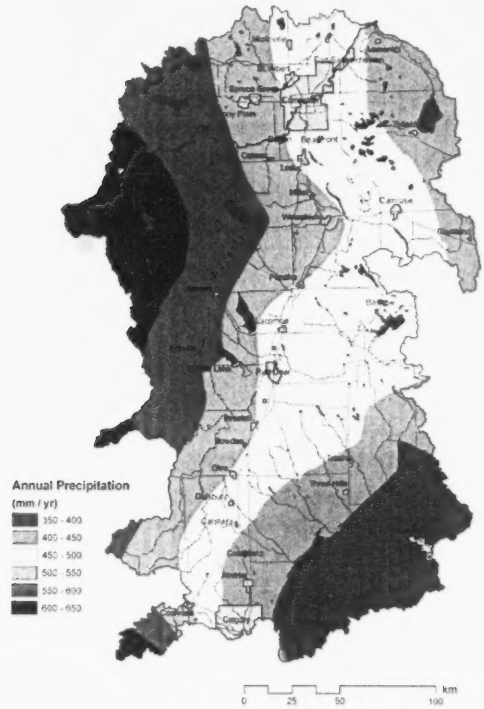

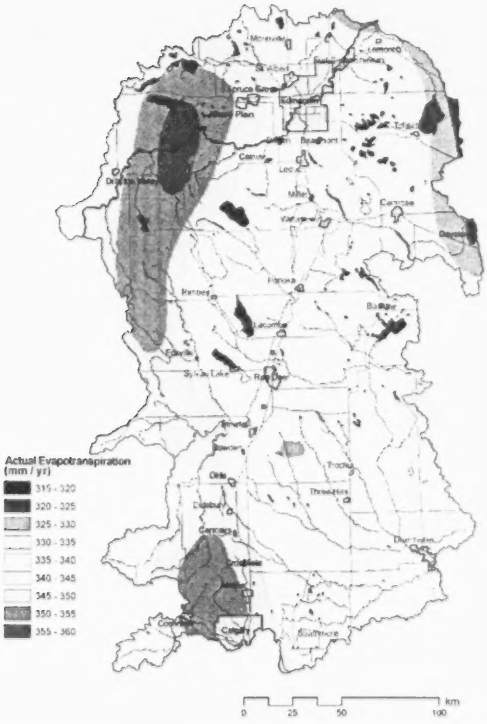

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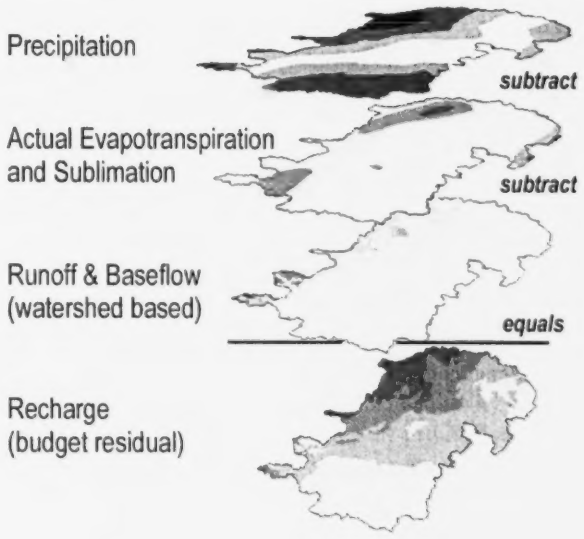
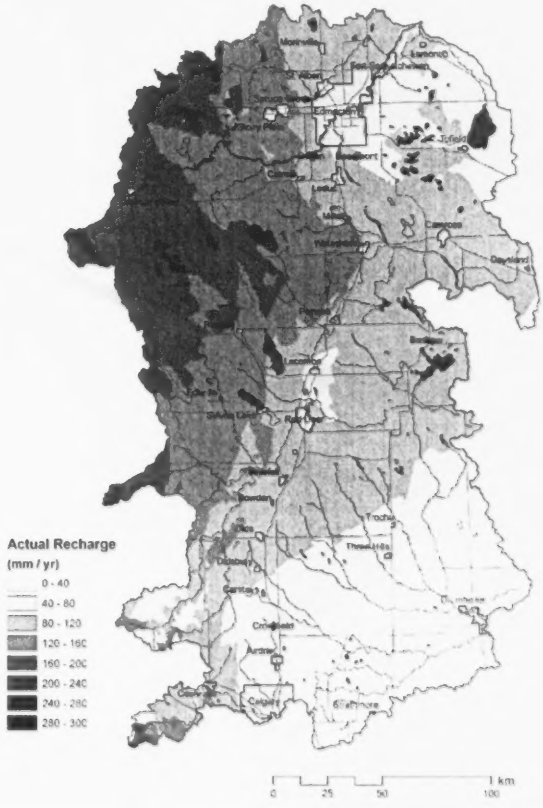
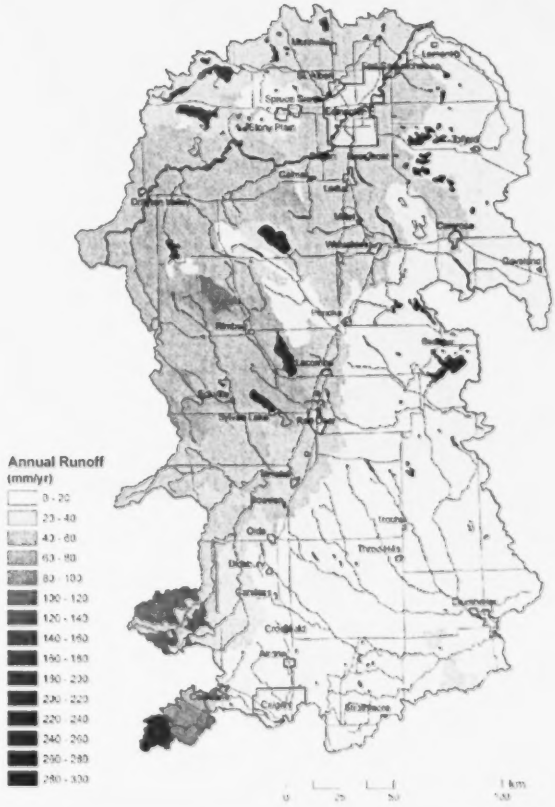
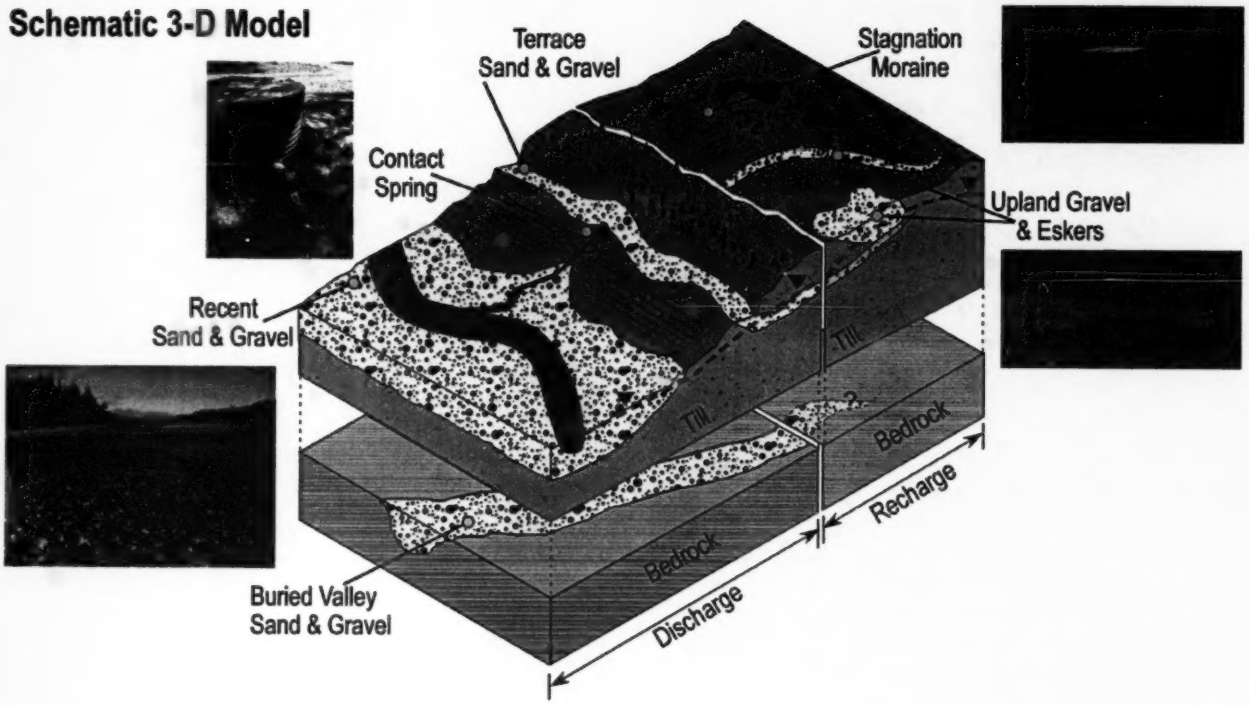
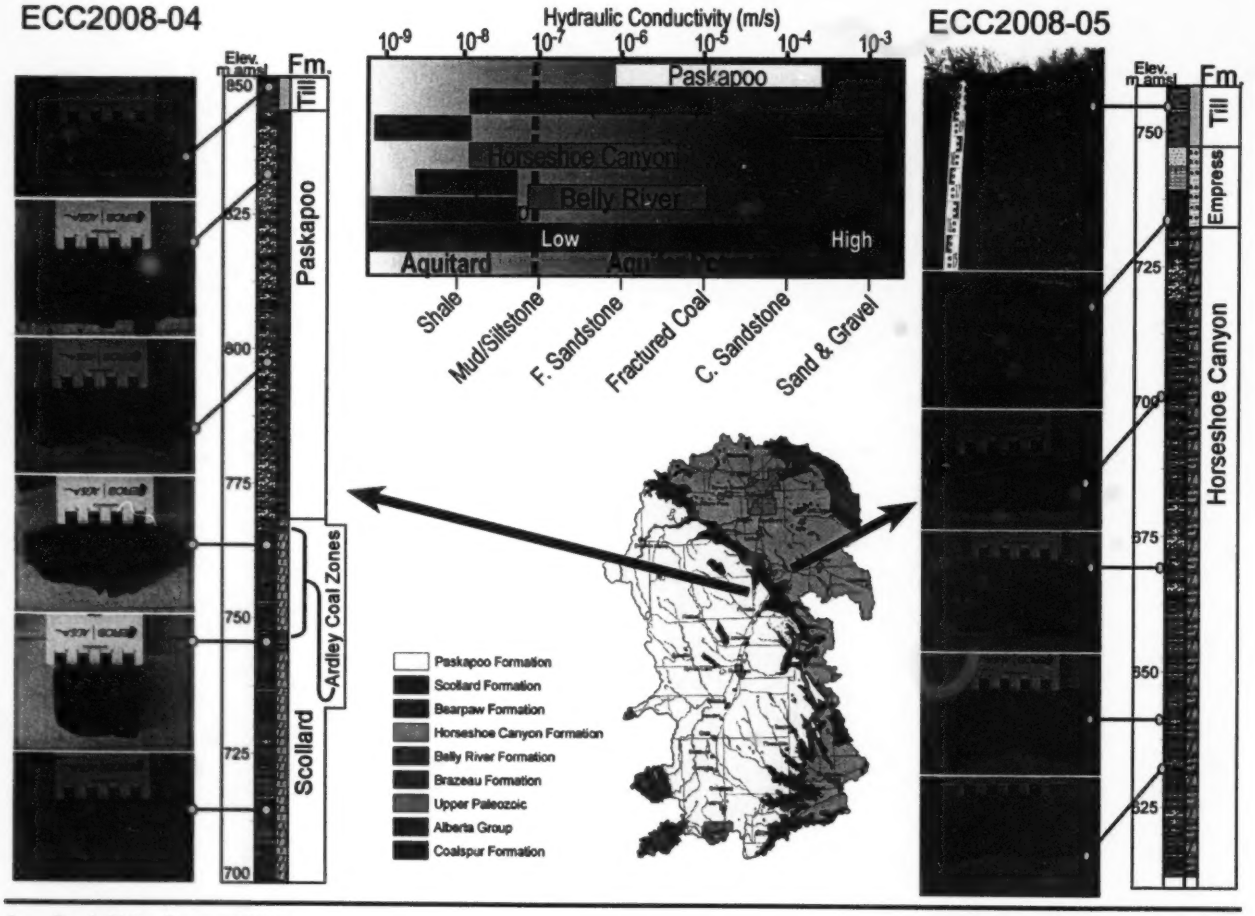







Schematic 3-D Model
Terrace
Sand & Gravel
Stagnation
Moraine
Contact
Spring
Upland Gravel
& Eskers
Recent
Sand & Gravel
Till
Till
Bedrock
Recharge
Bedrock
Buried Valley
Sand & Gravel
Discharge


ECC2008-04
Elev. m amsl
Fm.
850
825
800
775
750
725
700
Till
Paskapoo
Ardley Coal Zones
Scollard
Hydraulic Conductivity (m/s)
10-9
10-8
10-7
10-6
10-5
10-4
10-3
Paskapoo
Horseshoe Canyon
Belly River
Low
High
Aquitard
Aqu
Shale
Mud/Siltstone
F. Sandstone
Fractured Coal
C. Sandstone
Sand & Gravel
Paskapoo Formation
Scollard Formation
Bearpaw Formation
Horseshoe Canyon Formation
Belly River Formation
Brazeau Formation
Upper Paleozoic
Alberta Group
Coalspur Formation
ECC2008-05
Elev. m amsl
Fm.
750
725
700
675
650
625
Till
Empress
Horseshoe Canyon

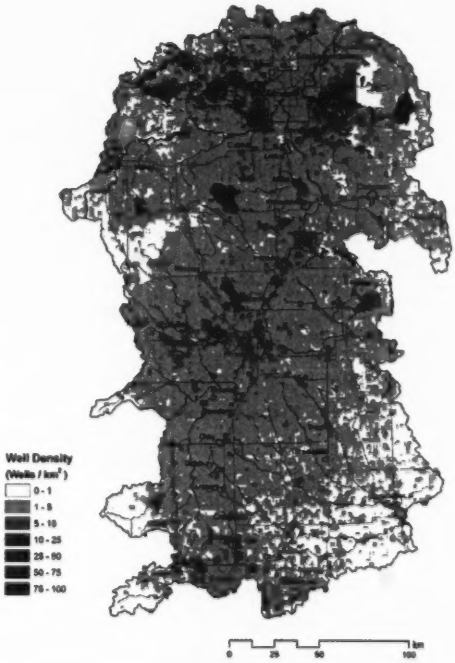
It is difficult to make a hydrogeological assessment of the area because the unconsolidated sediments overlying the bedrock in Alberta have a complex depositional history. To understand how groundwater behaves within the glacial drift, we first established the hydrogeological framework for these unconsolidated sediments. We developed aquifer vulnerability maps for both bedrock and drift aquifers that illustrate those areas that may be susceptible to surface contamination, as well as those where rapid vertical migration of fluids into deeper aquifers is possible. These maps use lithological data from the water well records to determine vertical permeability profiles for the drift throughout the ECC.

Hydrogeological characteristics of the bedrock formations in the ECC are similarly complex. In 2008, AGS drilled and cored 12 boreholes, each about 150 m deep, to characterize the lithology of the subsurface. The boreholes penetrated the Paskapoo, Scollard, Battle and Horseshoe Canyon formations. These formations are highly heterogeneous and exhibit a complex, internal geometry that includes low-permeability shale and mudstone, as well as higher permeability sandstone. Consequently, the hydraulic characteristics of these formations are highly variable, and include both permeable units with aquifer potential and low-yielding aquitards. The Paskapoo Formation is generally considered to have the best aquifer potential in the ECC, and contains several productive sandstone beds.

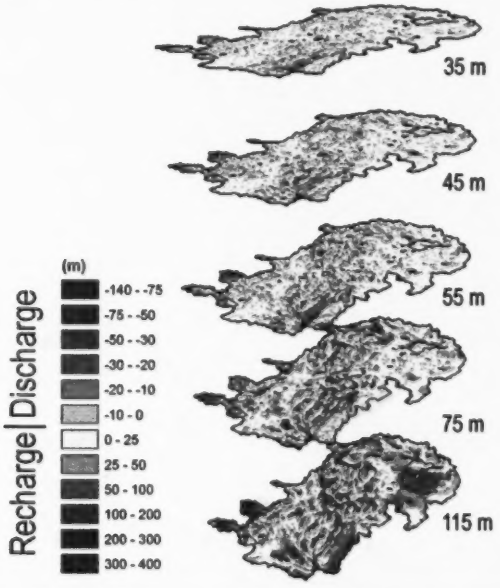
We produced a series of maps using water budget and hydrological maps combined with the hydrogeological assessment of the ECC. The majority of data used to generate the hydrogeological maps originated from Alberta Environment's water well database. The hydrogeological maps include

- well density,
- flowing wells,
- aquifer yield,
- water table surface,
- bedrock potentiometric surfaces,
- recharge and discharge areas, and
- aquifer vulnerability.

The combination of hydrogeology and hydrology maps lets us interpret the groundwater-flow system within the ECC. The hydrogeology maps will also help develop, calibrate and validate a numerical groundwater-flow model for the ECC. This model can assist with water management and policy decisions as the provincial waterscape evolves. The ECC hydrogeological atlas will include summaries of the drift model, bedrock model, hydrology, hydrogeology, hydrogeochemistry and preliminary findings of the numerical modelling. We anticipate the atlas will serve as a reference for a wide range of users, as well as build upon the heritage of groundwater science in the province. ❖



Difference between Land Surface and Bedrock Potentiometric Surfaces



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In 1907, the Alberta government founded the University of Alberta in Edmonton and named Henry Tory its president, giving him the task of building a modern university. His vision of what that university should become and how to accomplish these goals was contagious. Dr. E.K. Broadus, the first English professor of the University of Alberta, said, *"In June 1908, the President of a University not yet in being, in a Province I had never heard of, in a country I had never visited, came to Harvard and offered me the Professorship of English. I think that what I accepted was not the position or the salary, but the man!"*

One of the many Tory biographers, R.W. Boyle, suggested that, *"Undoubtedly many a young man, professor, lecturer, instructor, demonstrator, came to the new University ... all inspired by the enthusiasm of the man who had selected them."*

In 1921, an institution with many of the same goals Henry Tory believed in was formed: the Scientific and Industrial Research Council of Alberta. According to E.A. Corbett, the development of this research council was primarily the work of Dr. Tory. Not surprisingly, Henry Tory was named its first chairman. This institution later became the Alberta Research Council (ARC), recently renamed Alberta Innovates – Technology Futures.

Henry Tory's views on the need for scientific research led to his involvement in this area at a federal level as well. He became a council member of the National Research Council in 1923. Later that same year, Henry Tory became the chairman of the council and drafted the act that brought the National Research Council Laboratories (NRCL) officially into being.

In 1928, he resigned as president of the University of Alberta to accept his new post as president and chief executive officer of the NRCL in Ottawa. Henry Tory served the NRCL until the end of his term in 1935. He is credited with steering this organization through a difficult political and economic period, in the process laying the foundation for a well respected research organization.

His next achievement was heading the committee that opened Carleton College in 1942, later to become Carleton University. This new institution provided educational opportunities for the men and women who had their educational careers halted by the call to help in the war effort. At 79, Henry Tory was named the college's first president.

Henry Tory was a great leader who had a knack for finding the right person for a job. Although not a geologist or geological engineer, during the founding of the University of Alberta, Henry Tory recruited fellow McGill alumnus, John Allan, to head the U of A's geology department. This position led John Allan to become the founder of AGS in 1920. Henry Tory also supported John Allan's inclusion into the ARC, with which the AGS was affiliated during its first 70+ years.

Founders of organizations shape the organizations and people of which they are a part. Henry Tory's belief that science should benefit society influenced all of the organizations he worked with and the people within them. Through his support of John Allan and geological sciences in Alberta, we can see Henry Tory's contribution in furthering our understanding of Alberta's geology. Henry Tory passed away in 1947, leaving a remarkable legacy of service to his country. The institutions he founded remind us of his vision and hard work. ❖

Mineral Core Research Facility Revitalization Project

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The Mineral Core Research Facility (MCRF) contains a valued and eclectic core collection of Alberta's uppermost bedrock stratigraphy (<250 m depth).

This collection is publicly available for mineral exploration and research purposes by prospectors, mineral exploration companies and academia. Visit http://www.ags.gov.ab.ca/mcrf for a list of the core samples.

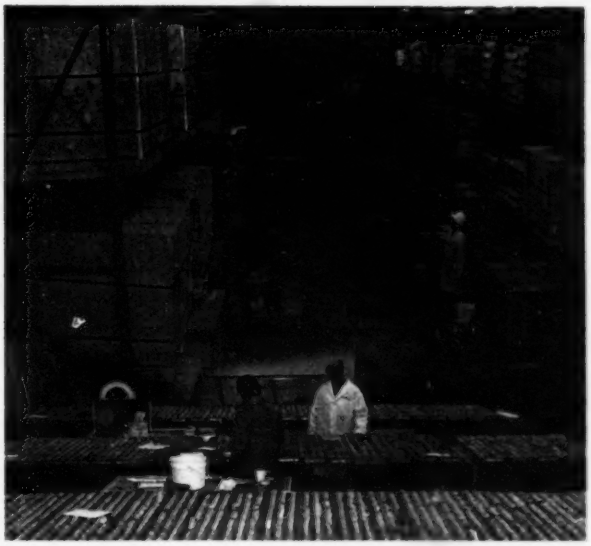
To make the facility more relevant to industry, government and the public, Alberta Geological Survey will create a special collection of core samples from key stratigraphic units and mineral occurrences in Alberta.

To ensure the new collection's validity, we will evaluate the current core catalogue to decide which samples to keep. Discarded samples may include damaged core from a specific area with multiple, closely spaced drill collars.

If your company is interested in claiming specific core, please send an e-mail to AGS-MCRF@ercb.ca by September 30, 2010.

Alberta Geological Survey will complete the review process by October 30, 2010. We will advise you whether we will keep or discard samples you have specified.

Your company must arrange for immediate transport of the core. If multiple companies request the same core, the company that donated the core will have right of first refusal. If a request does not include the original donor, we will offer the core on a first come, first remove basis. If a core sample marked for discard receives no exploration company interest, we will offer it to universities and colleges prior to discarding it. ❖



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OFR 2010-02	Mineralogy, Permeametry, Mercury Porosimetry, Pycnometry and Scanning Electron Microscope Imaging of Duvernay and Muskwa Formations: Shale Gas Data Release.
OFR 2010-03	Mineralogy, Permeametry, Mercury Porosimetry, Pycnometry and Scanning Electron Microscope Imaging of the Montney Formation: Shale Gas Data Release.
OFR 2010-04	Rock Eval, Total Organic Carbon and Adsorption Isotherms of the Duvernay and Muskwa Formations in Alberta: Shale Gas Data Release.
OFR 2010-05	Rock Eval, Total Organic Carbon and Adsorption Isotherms of the Montney Formation in Alberta: Shale Gas Data Release.
OFR 2010-06	Organic Petrography of the Duvernay and Muskwa Formations in Alberta: Shale Gas Data Release.
OFR 2010-07	Organic Petrography of the Montney Formation in Alberta: Shale Gas Data Release.

The Career of Henry Marshall Tory

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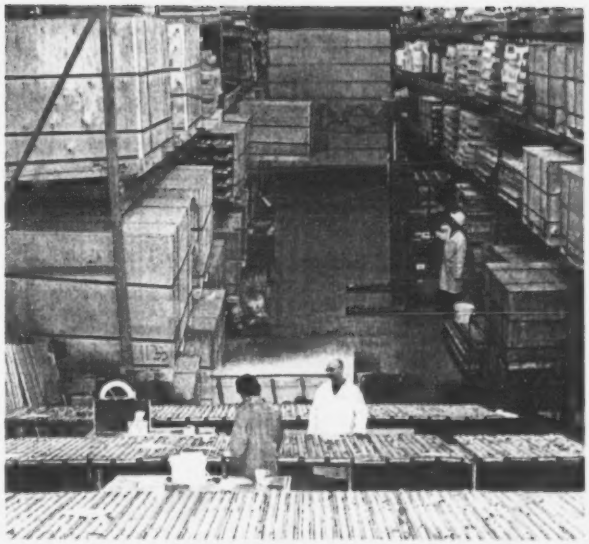
To ensure the new collection's validity, we will evaluate the current core catalogue to decide which samples to keep. Discarded samples may include damaged core from a specific area with multiple, closely spaced drill collars.

If your company is interested in claiming specific core, please send an e-mail to AGS-MCRF@ercb.ca by September 30, 2010.

Alberta Geological Survey will complete the review process by October 30, 2010. We will advise you whether we will keep or discard samples you have specified.

Your company must arrange for immediate transport of the core. If multiple companies request the same core, the company that donated the core will have right of first refusal. If a request does not include the original donor, we will offer the core on a first come, first remove basis. If a core sample marked for discard receives no exploration company interest, we will offer it to universities and colleges prior to discarding it. ❖



Recently Released Publications

www.ags.ab.ca/publications

OFR 2010-02	Mineralogy, Permeametry, Mercury Porosimetry, Pycnometry and Scanning Electron Microscope Imaging of Duvernay and Muskwa Formations: Shale Gas Data Release.
OFR 2010-03	Mineralogy, Permeametry, Mercury Porosimetry, Pycnometry and Scanning Electron Microscope Imaging of the Montney Formation: Shale Gas Data Release.
OFR 2010-04	Rock Eval, Total Organic Carbon and Adsorption Isotherms of the Duvernay and Muskwa Formations in Alberta: Shale Gas Data Release.
OFR 2010-05	Rock Eval, Total Organic Carbon and Adsorption Isotherms of the Montney Formation in Alberta: Shale Gas Data Release.
OFR 2010-06	Organic Petrography of the Duvernay and Muskwa Formations in Alberta: Shale Gas Data Release.
OFR 2010-07	Organic Petrography of the Montney Formation in Alberta: Shale Gas Data Release.

Conferences Involving Alberta Geological Survey

Canadian Geotechnical Society
September 13 to 15, 2010
Hyatt Regency Hotel
Calgary, AB

Canadian Unconventional Resources and International Petroleum Conference (CURIPC10)
October 19 to 21, 2010
BMO Center at Stampede Park
Calgary, AB

Alberta Urban Municipalities Association Convention
November 23 to 25, 2010
Shaw Conference Centre
Edmonton, Alberta

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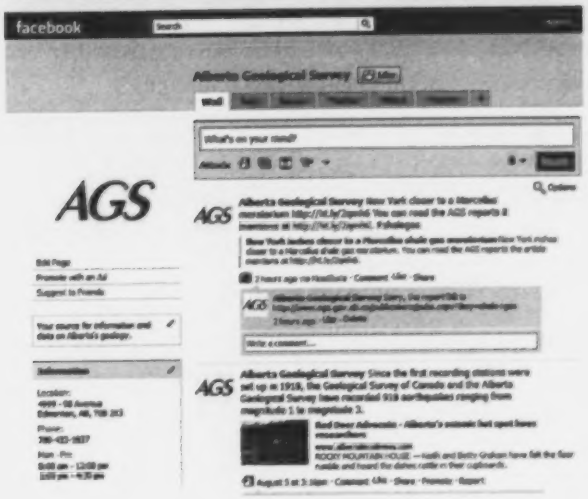

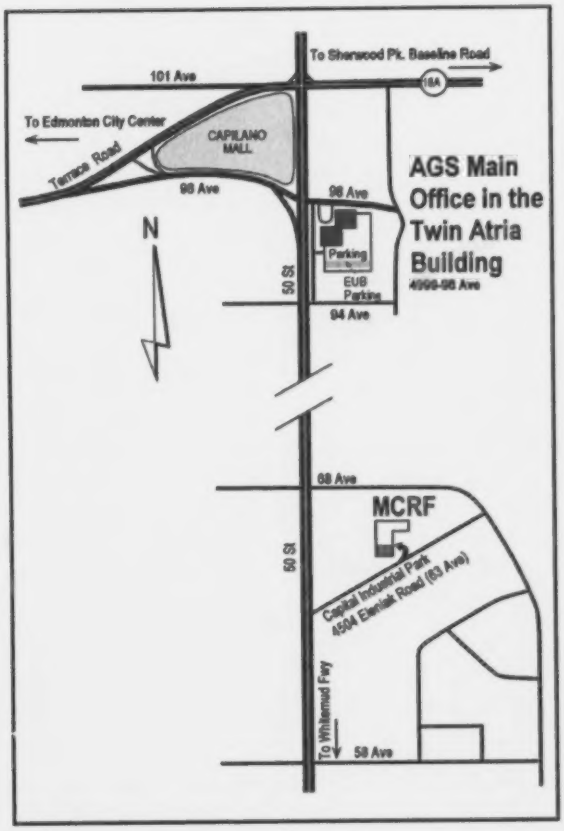

AGS Locations

Alberta Geological Survey is part of the ERCB Edmonton office.

#402, 4999 - 98th Avenue
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Canada T6B 2X3
Tel: (780) 422-1927
www.ags.gov.ab.ca

Please call in advance to meet with one of our staff members or to visit our library.

Mineral Core Research Facility (MCRF)
4504 Eleniak Road
Edmonton, Alberta

For information on the MCRF or to book a visit, contact Rob Natyshen at (780) 466-1779 or Rob.Natyshen@ercb.ca

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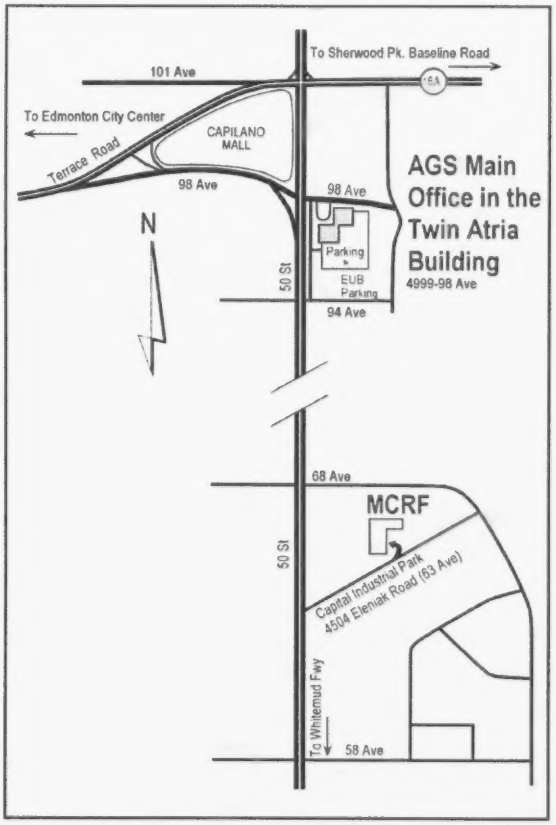

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